

## Performance Characteristics of 15 cm Carbon-Carbon Composite Grids

Charles E. Garner, Juergen Mueller and John R. Brophy

*Jet Propulsion Laboratory  
California Institute of Technology  
Pasadena, CA 91109*

### Abstract

Concerns about high launch costs have resulted in an increased interest in small spacecraft technology for planetary exploration, ion propulsion systems may considerably reduce overall spacecraft mass for planetary missions. In order to facilitate the use of ion propulsion on small spacecraft, however, lightweight, high performance ion engines are required. The performance of an ion thruster depends to a large extent on the design and performance of the ion extraction grids. Light weight carbon-carbon composite grids offer the potential of low grid erosion, increasing power handling capability and lifetime of the ion engine. Thus, a reduction in the number of engines required for a particular mission can be expected, resulting in a decreased propulsion system mass.

Ion optics measuring 15 cm in diameter and 0.5- 1.0 mm in thickness were fabricated from carbon-carbon composite using unidirectional tape. Plate flatness varied by less than  $\pm 0.05$  mm. Electric discharge machining was used to drill approximately 4300 holes of diameter  $1.905 \text{ mm} \pm 0.02 \text{ mm}$  into the screen grid to an open area fraction of 0.67. Accelerator and decelerator grids having lower open area fractions are fabricated using conventional mechanical drilling techniques. Cumulative hole placement errors are expected within  $\pm 0.05$  mm and will be verified by measurement. Perveance data over a range of total voltages and specific impulses will be reported for the carbon-carbon grid using a recently developed small-scale 15 cm ion engine as a test bed. Material properties such as coefficient of thermal expansion, flexural modulus and flexural strength will be determined using small carbon-carbon samples featuring hole patterns fabricated according to specifications identical to the 15 cm grid. Polished carbon-carbon composite samples will be placed into an ion beam to measure sputter yield data over a range of ion energies. By simultaneously placing other material samples, such as molybdenum, into the ion beam, comparative erosion measurements under identical plasma conditions are possible.